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(54) **MULTIPLE DEVICE APPARATUS, SYSTEMS, AND METHODS**

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Related U.S. Application Data

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CPC **G11C 8/18** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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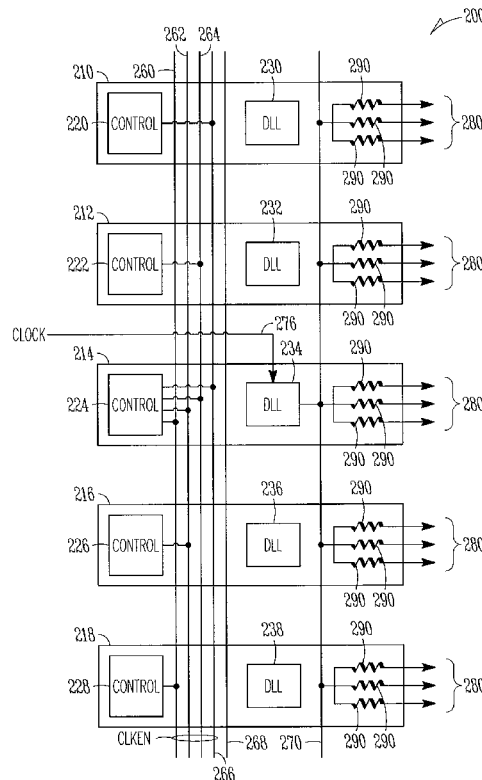
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(57) **ABSTRACT**

Apparatus, systems, and methods are disclosed that operate to generate a clock signal in a die in a stack and to receive the clock signal in another die in the stack. Additional apparatus, systems, and methods are disclosed.

20 Claims, 5 Drawing Sheets



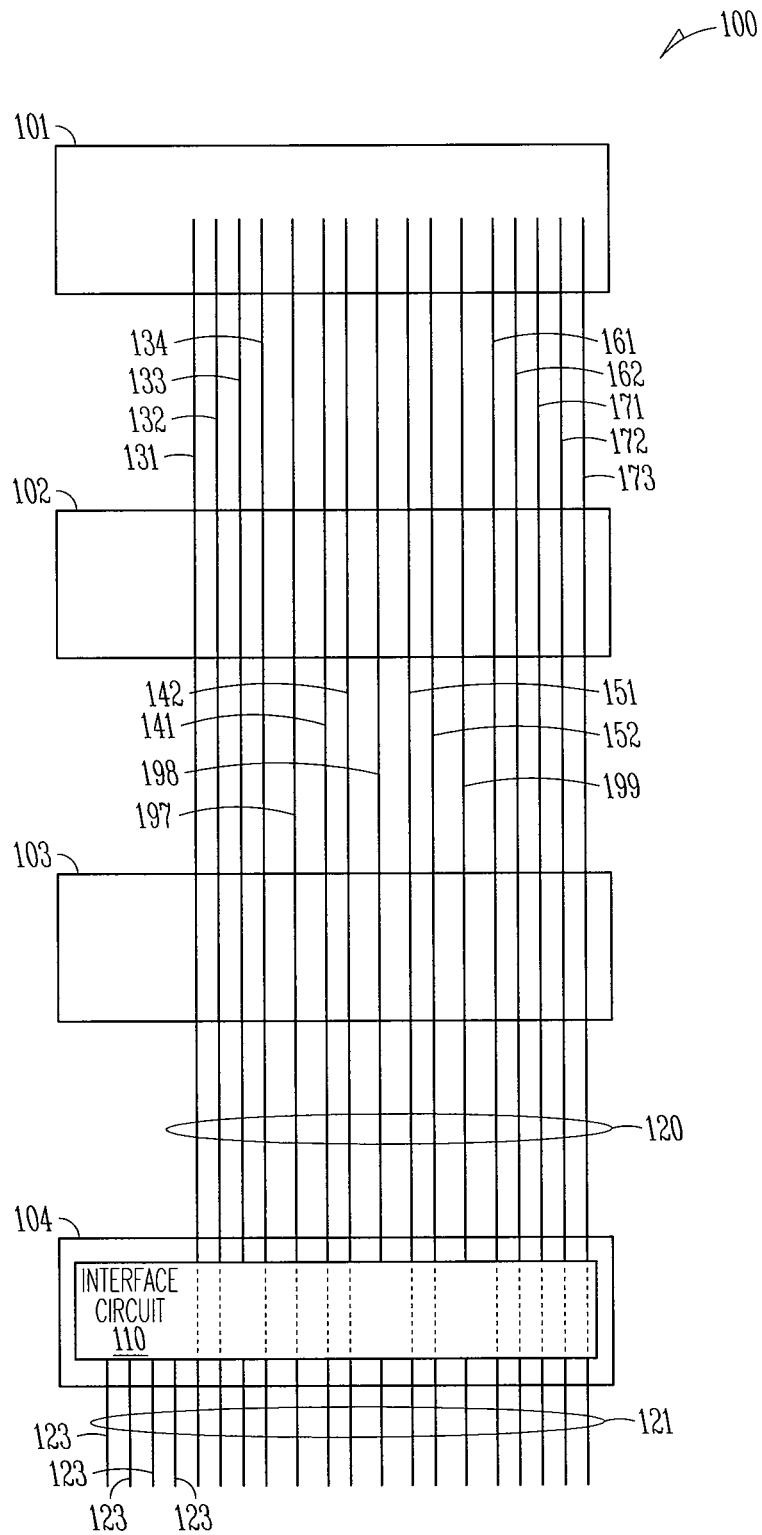


FIG. 1

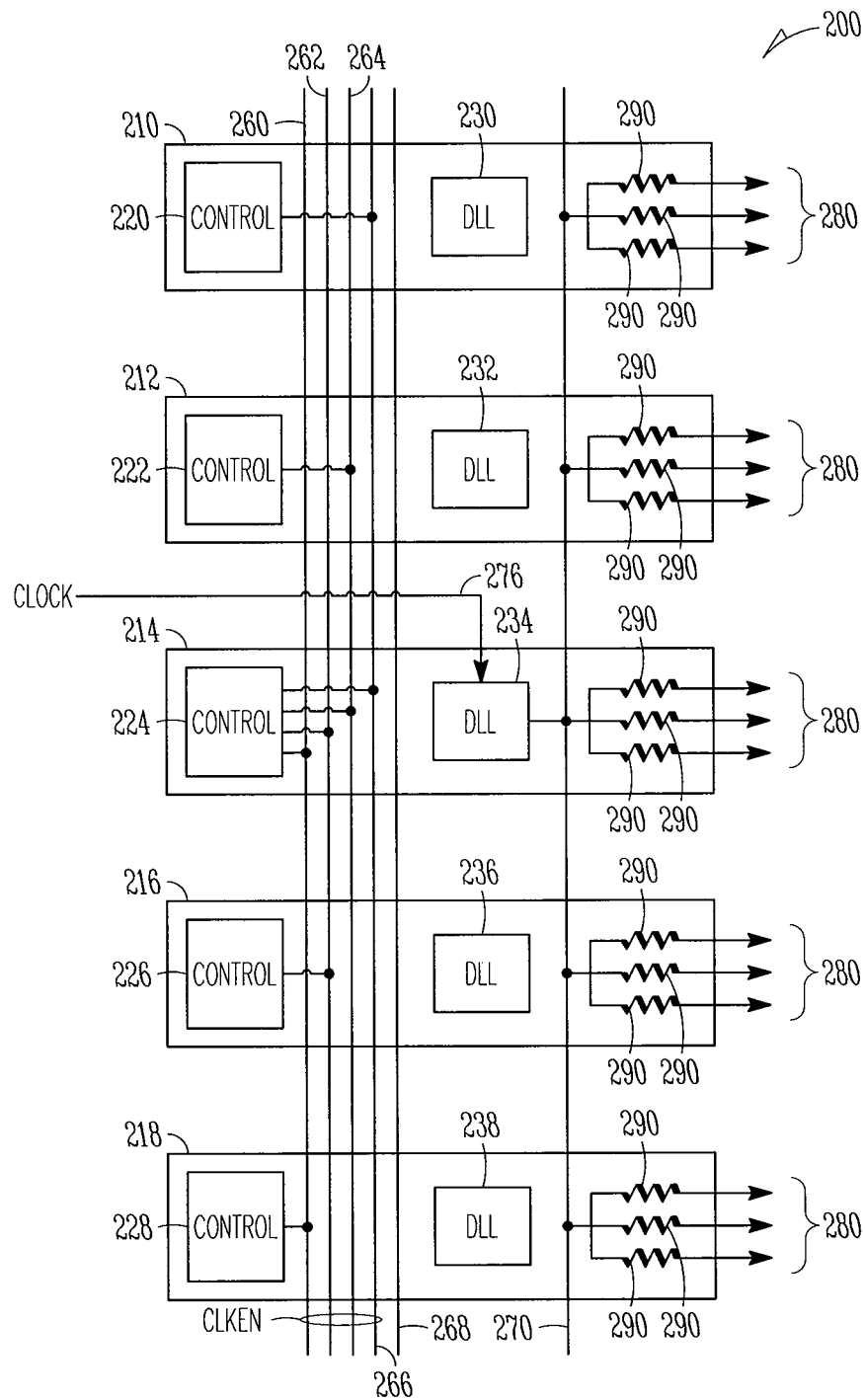


FIG. 2

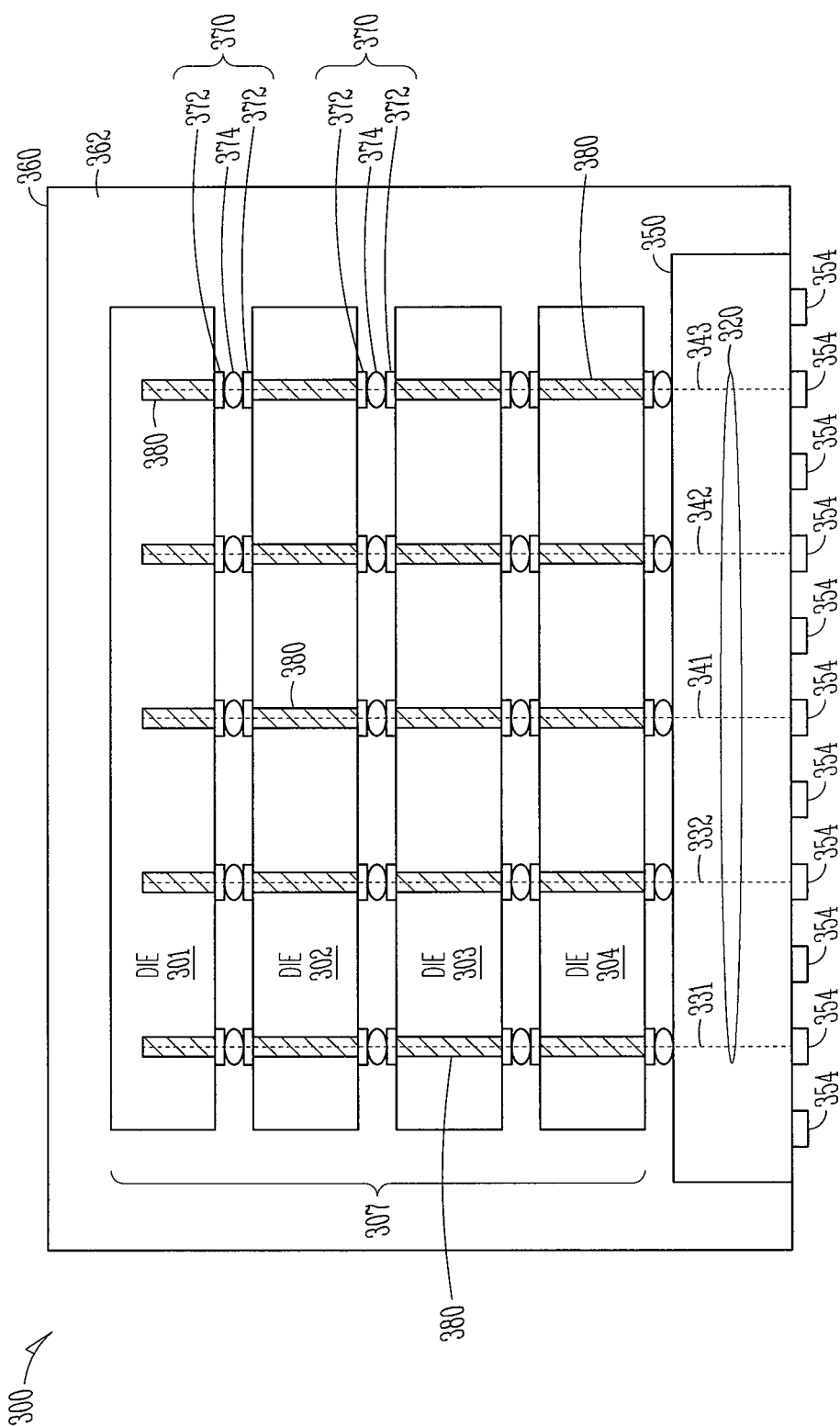
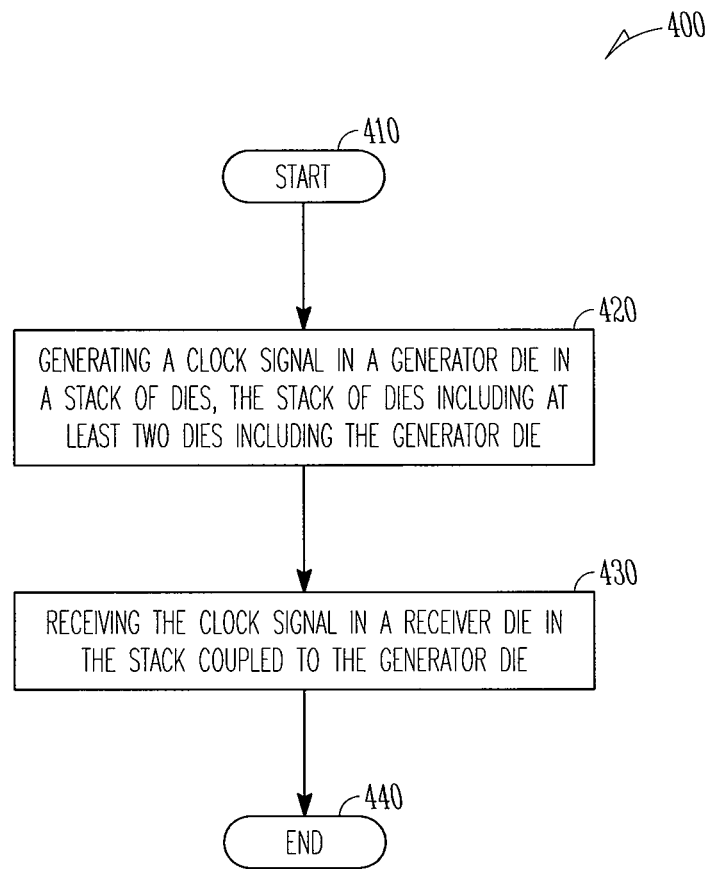


FIG. 3

*FIG. 4*

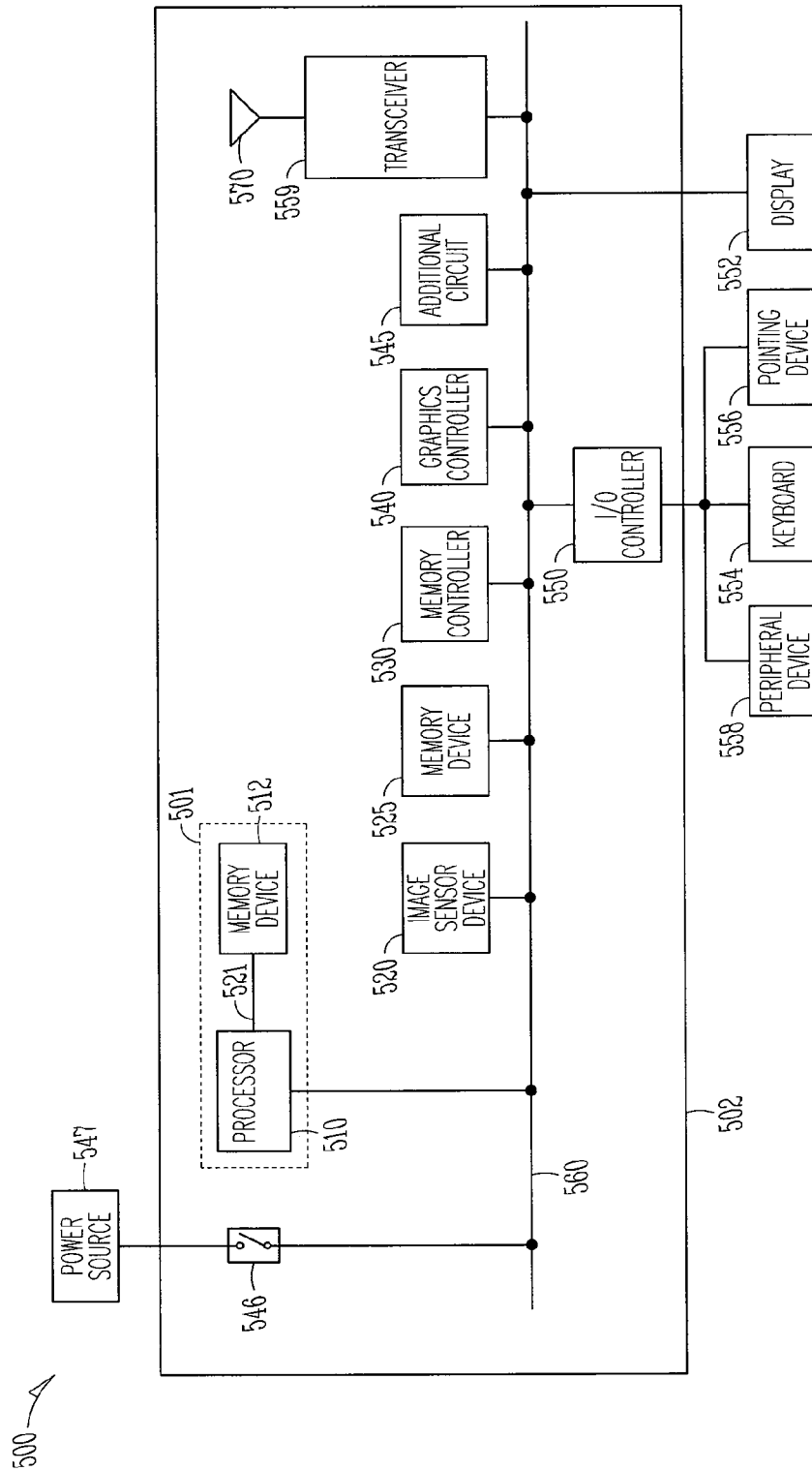


FIG. 5

MULTIPLE DEVICE APPARATUS, SYSTEMS, AND METHODS

PRIORITY APPLICATIONS

This is a continuation of U.S. application Ser. No. 13/652,108, filed Oct. 15, 2012, which is a continuation of U.S. application Ser. No. 12/163,856, filed Jun. 27, 2008, now issued as U.S. Pat. No. 8,289,806, all of which are incorporated herein by reference in their entirety.

BACKGROUND

Integrated circuit devices, including memory devices, often are used in computers and other electronic products, e.g., digital televisions, digital cameras, and cellular phones, to store data and other information. Multiple integrated circuit devices are often used together in a system.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a block diagram of a stack including integrated circuit dies and channels according to various embodiments of the invention.

FIG. 2 is a block diagram of a stack including integrated circuit dies and channels according to various embodiments of the invention.

FIG. 3 is a partial cross section of an integrated circuit package having multiple separate integrated circuit dies arranged in a stack according to various embodiments of the invention.

FIG. 4 is a flow diagram of operations or methods according to various embodiments of the invention.

FIG. 5 is a block diagram of a system according to various embodiments of the invention.

DETAILED DESCRIPTION

Systems including multiple devices typically generate a clock signal in each device, and each device generating a clock signal consumes a substantial amount of power to do so. The inventors have discovered that the challenges noted above, as well as others, can be addressed by distributing a clock signal from a delay-locked loop (DLL) or a phase-locked loop (PLL) or multiple DLLs or PLLs in one or more integrated circuit dies to a collection of integrated circuit dies. Other DLLs or PLLs in the collection can be shut off to reduce power consumption.

FIG. 1 is a block diagram of a stack 100 including integrated circuit dies (dies) and channels according to various embodiments of the invention. A stack of dies includes a collection or plurality of dies coupled together to exchange data, address, and control signals. The stack 100 includes several separate dies 101, 102, 103, and 104 and groups 120 and 121 of channels to transfer information. Each of the dies 101, 102, 103, and 104 is formed of semiconductor material and includes electronic circuitry. The dies 101, 102, 103, and 104 may communicate with each other through the channels in the group 120 and with other external devices such as a processor, a memory controller, or another device through an interface circuit 110 in the die 104. The interface circuit 110 may be a logic circuit. The channels in the groups 120 and 121 extend through or into the dies 101, 102, 103, and 104 in the stack 100. The dies 101, 102, 103, and 104 may have a different order, arrangement, or orientation with respect to each other in the stack 100 according to various embodiments

of the invention. The stack 100 may include more or fewer dies according to various embodiments of the invention.

Information such as one or more of data, address, and control information or other information may be transferred through the channels in the groups 120 and 121. The group 120 includes multiple channels 131, 132, 133, 134, 141, 142, 151, 152, 161, 162, 171, 172, 173, 197, 198, and 199, and may include more channels. The channels in the group 121 include the channels 131-199 in the group 120 and additional channels 123. Information is transferred among the dies 101, 102, 103, and 104 through the channels 131-199 in the group 120, and information such as data and control information may also be transferred through the additional channels 123 between the interface circuit 110 and an external device such as a processor, a memory controller, or another device. Each of the channels 123-199 may be an electrically conductive path.

The channels 131-199 in the group 120 may be arranged into different buses to transfer different types of information. For example, the channels 131, 132, 133, and 134 may form a data bus to transfer information representing data to be stored in or read from the dies 101, 102, 103, and 104. The channels 141 and 142 may form an address bus to transfer information representing an address of a location in the dies 101, 102, 103, and 104 where data may be stored. The channels 151 and 152 may form a control bus to transfer control information to control operations of the stack 100. The channels 161 and 162 may form a power bus to provide power to the dies 101, 102, 103, and 104. For example, the channels 161 and 162 may carry voltages Vcc and Vss, where Vss can be a ground voltage reference. The channels 171, 172, 173, 197, 198, and 199 may be added to the above-described buses or be used for other purposes.

In various embodiments, a single DLL or PLL in one of the dies 101-104 in the stack 100 is operated to generate a clock signal that is distributed to others of the dies 101-104 in the stack 100 through one or more of the channels 131-199 in the group 120. Other DLLs or PLLs in the dies 101-104 are capable of being shut off to reduce power consumption in the stack 100. In various embodiments, two or more DLLs or PLLs in the stack 100 are operated to generate clock signals that are distributed to the dies 101-104 through two or more of the channels 131-199 in the group 120. Other DLLs or PLLs in the dies 101-104 can be shut off to reduce power consumption in the stack 100. In various embodiments, one or more of the dies 101-104 in the stack 100, such as the die 104, may operate a DLL or PLL to generate its own clock signal that is not distributed to others of the dies 101-104 in the stack 100.

The groups 120 and 121 shown in FIG. 1 include a specific number of channels as an example. The number of channels in the groups 120 and 121 may vary. For example, the group 120 may include tens, hundreds, or thousands of channels extending through or into the dies 101, 102, 103, and 104 in the stack 100.

The stack 100 shown in FIG. 1 may include only a single memory device or processor such that parts of the single memory device or processor may be distributed among the dies 101, 102, 103, and 104. The stack 100 may also include multiple memory devices or processors where each of the dies 101, 102, 103, and 104, by itself, includes a separate memory device or processor. The dies 101-104 may have a different order, arrangement, or orientation with respect to each other in the stack 100 according to various embodiments of the invention. The dies 101-104 may include processors and/or memory devices such as Flash memory devices, DRAMs, or SDRAMs. The dies 101-104 may be of the same design or may be of different designs.

FIG. 2 is a block diagram of a stack 200 including integrated circuit dies and channels according to various embodiments of the invention. The stack 200 includes five separate integrated circuit dies 210, 212, 214, 216, and 218. Each of the integrated circuit dies 210, 212, 214, 216, and 218 is formed from a semiconductor material and includes electronic circuitry. Each of the dies 210, 212, 214, 216, and 218 includes a respective control circuit 220, 222, 224, 226, and 228 and a respective DLL 230, 232, 234, 236, and 238. The dies 210, 212, 214, 216, and 218 may include processors and/or memory devices such as Flash memory devices, DRAMs, or SDRAMs. The dies 210, 212, 214, 216, and 218 may be of the same design or may be of different designs.

The stack 200 includes several channels 260, 262, 264, 266, 268, and 270 to transfer information between the dies 210-218. The channels 260-270 may be electrically conductive paths. The channels 260-270 extend through or into the dies 210-218. The stack 200 may include more channels that are not shown.

DLLs such as the DLLs 230, 232, 234, 236, and 238 are used to generate an internal periodic signal such as an internal clock signal based on a periodic reference signal such as, for example, an external clock signal. Each DLL adjusts a phase of the internal periodic signal to maintain a specific phase relationship with the periodic reference signal. DLLs are used, for example, in high-speed clocked memories such as synchronous dynamic random access memory (SDRAM) devices. Each DLL consumes a substantial amount of power when operating to generate an internal periodic signal such as an internal clock signal.

In various embodiments, an internal clock signal generated by one of the DLLs 230, 232, 234, 236, and 238 is received by all of the dies 210-218 in the stack 200. In various embodiments, some, but not all, of the dies 210-218 in the stack 200 receive the internal clock signal. The internal clock signal may also be called a clock synchronization signal. The DLLs 230-238 not generating the internal clock signal are capable of being shut off to reduce power consumption. According to various embodiments of the invention shown in FIG. 2, the DLL 234 in the die 214 is coupled to receive an external clock signal on a line 276 and is operated to generate an internal clock signal by adjusting a phase of the internal clock signal to maintain a specific phase relationship with the external clock signal on the line 276. The die 214 may be called a generator die or a source die. The internal clock signal is available within the die 214 and is coupled from the DLL 234 to the channel 270 and thereafter distributed to one or more of the other dies 210, 212, 216, and 218 in the stack 200 through the channel 270. The dies 210, 212, 216, and 218 in the stack 200 receiving the internal clock signal may be called receiver dies.

The DLLs 230-238 not generating the internal clock signal may be shut off by gating the external clock signal off with, for example, a NAND gate. An enable/disable control line for each of the DLLs 230-238 may be set using a fuse or an antifuse.

Each of the dies 210, 212, 214, 216, and 218 includes a respective plurality of clock distribution terminals 280 in a clock distribution tree to distribute a clock signal generated by a DLL. Three clock distribution terminals 280 are shown extending from each of the dies 210, 212, 214, 216, and 218 from conductive lines that have a parasitic resistance 290 and a parasitic capacitance (not shown). Each clock distribution terminal 280 may be coupled to a data output terminal (not shown) such as, for example, a D-type flip-flop. More specifically, each clock distribution terminal 280 may be coupled to a clock input of a D-type flip-flop to clock data received at

a D input through the D-type flip flop. The clock signal generated by a DLL may be distributed by straight line conductors or a T-shaped clock distribution structure according to various embodiments.

The dies 210-218 in the stack 200 may communicate a request for a clock signal with a clock enable (CLKEN) signal coupled to one or more of the channels 260-270. With respect to the various embodiments shown in FIG. 2, each die 210, 212, 216, and 218 may generate its own CLKEN signal to indicate to the die 214 that it is requesting the internal clock signal for a purpose such as, for example, data transmission. The control circuit 224 may generate a CLKEN signal internally for the die 214 to indicate whether the die 214 itself will use the internal clock signal to be generated. The control circuit 220 in the die 210 may generate a CLKEN signal coupled to the channel 266. The control circuit 222 in the die 212 may generate a CLKEN signal coupled to the channel 264. The control circuit 226 in the die 216 may generate a CLKEN signal coupled to the channel 262. The control circuit 228 in the die 218 may generate a CLKEN signal coupled to the channel 260. The channel 268 may be used for a purpose unrelated to the internal clock signal.

The die 214 is coupled to the channels 260-266 to receive the CLKEN signals from the dies 210, 212, 216, and 218. One or more of the dies 210-218 may be in an idle state in which it is not performing tasks that use the internal clock signal. The control circuit 224 in the die 214 receives the CLKEN signals on the channels 260-266 from the dies 210, 212, 216, and 218 and instructs the DLL 234 to generate the internal clock signal when at least one of the dies 210, 212, 214, 216, and 218 requests it. The DLL 234 can be shut off when none of the dies 210-218 requests the internal clock signal to perform an operation. The channels 260-270 between the dies 210, 212, 214, 216, and 218 are short enough such that clock skew and clock jitter resulting from the distribution of the clock signal across the dies 210-218 do not substantially impact performance.

In various embodiments, each of the dies 210-218 in the stack 200 may include a PLL rather than a DLL to generate an internal clock signal. PLLs are used to generate an internal periodic signal such as an internal clock signal based on a periodic reference signal such as, for example, an external clock signal. A PLL adjusts a phase of the internal periodic signal with an oscillator to maintain a specific phase relationship with the periodic reference signal. PLLs are used, for example, in high-speed clocked memories such as synchronous dynamic random access memory (SDRAM) devices. A PLL may be shut off with an enable/disable control line that would either keep the oscillator in a reset state or set an oscillator voltage to zero volts. An enable/disable control line for each of the PLLs may be set using a fuse or an antifuse. In various embodiments, the dies 210-218 in the stack 200 may include an assortment of PLLs and DLLs to generate internal clock signals.

In various embodiments, two or more DLLs or PLLs in the stack 200 are operated to generate clock signals that are distributed to the dies 210-218 through two or more of the channels 260-270. Other DLLs or PLLs in the dies 210-218 are capable of being shut off to reduce power consumption in the stack 200. One of the dies 210-218 having a DLL or PLL operated to generate a clock signal may be called a generator die or a source die. Another of the dies 210-218 having a DLL or PLL operated to generate a clock signal may be called an auxiliary die operated to generate an auxiliary clock signal.

The dies 210-218 may have a different order, arrangement, or orientation with respect to each other in the stack 200 according to various embodiments. The stack 200 may

5

include more or fewer dies according to various embodiments. In various embodiments, one or more of the dies 210-218 in the stack 200 include a DLL or a PLL, and others of the dies 210-218 do not include a DLL or a PLL. The dies 210-218 may communicate with other external devices such as a processor, a memory controller, or another device through an interface circuit (not shown).

FIG. 3 is a partial cross section of an integrated circuit package 300 having multiple separate integrated circuit dies 301, 302, 303, and 304 arranged in a stack 307 according to various embodiments of the invention. Each of the integrated circuit dies 301, 302, 303, and 304 is formed from a semiconductor material and includes electronic circuitry. The dies 301-304 may each include circuit components of a single memory device or a single processor. Alternatively, the dies 301-304 collectively may include circuitry of a memory device or a processor.

The package 300 includes a group 320 of channels 331, 332, 341, 342, and 343. Each channel 331, 332, 341, 342, and 343 is shown as a broken line in FIG. 3 that extends through or into the dies 301, 302, 303, and 304 in the stack 307. Each channel 331, 332, 341, 342, and 343 may be a conductive path and may be referred to as a "through wafer interconnect" (TWI) or a "through silicon via" (TSV).

The package 300 includes a support 350 coupled to the dies 301-304. The support 350 may be a ceramic or organic package substrate. Multiple contacts 354 are coupled to the support 350 to enable the dies 301-304 to communicate with another device such as a processor or a memory controller. Some of the contacts 354 may form portions of the channels 331, 332, 341, 342, and 343. The package 300 includes an enclosure 360 which may enclose at least a part of the support 350 and the dies 301-304. An interior space 362 between the enclosure 360 and the dies 301-304 may be filled with a filling material, a gas, a liquid, or a combination thereof. The filling material may include a polymer material.

An interface circuit (not shown) may be located in the die 304, and this interface circuit may be a logic circuit and may be similar to or identical to the interface circuit 110 shown in FIG. 1. The interface circuit may include circuit components, for example buffers and I/O drivers, to facilitate the transfer of information at appropriate data transfer rates between the dies 301, 302, 303, and 304 and another device such as a processor or a memory controller (not shown).

The dies 301-304 can be substantially equal in size and are stacked vertically on, or with respect to, the support 350. In other words, the dies 301-304 are stacked along a line substantially perpendicular to a larger surface of the support 350. The dies 301-304 may have a different order, arrangement, or orientation with respect to the support 350 and/or to each other according to various embodiments of the invention.

The dies 301-304 may be formed separately and then arranged in the stack 307 as shown in FIG. 3. The dies 301-304 are attached to each other at a number of joints 370. Each joint 370 is located between two of the dies 301-304. Each joint 370 includes two bond pads 372, one bond pad 372 being adhered to each respective die 301-304, and an electrically conductive material 374 between the bond pads 372. The conductive material 374 may include one or more of solder, copper, or a conductive adhesive.

Each channel 331, 332, 341, 342, and 343 includes at least one via 380 with a conductive material inside the via 380 that extends into or through one of the dies 301, 302, 303, and 304. A via 380 in one of the dies 301-304 is coupled to a via 380 in another one of the dies 301-304 through one of the joints 370 that couple distal ends of the vias 380 to each other. The vias 380 extend all the way through some of the dies 302, 303, and

6

304 and extend into, but not through, the die 301 at one end of the stack 307. Each channel 331, 332, 341, 342, and 343 includes selected ones of the vias 380 extending through the dies 302, 303, and 304 and into the die 301 coupled together by the joints 370. The conductive material inside the vias 380 may include one or more of solder, copper, or another conductive material.

The stack 307 may be formed in a flip-chip fashion in which the die 301 is used as a base as shown in FIG. 3. The die 302 is attached to the die 301, the die 303 is then attached to the die 302, and finally the die 304 is attached to the die 303. The conductive material 374 is used to bond the bond pads 372 of one die to the bond pads 372 of another die while the dies 301, 302, 303, and 304 are assembled in the stack 307. After the dies 301, 302, 303, and 304 are assembled in the stack 307, they may be flipped over and then attached at the die 304 to the support 350. The package 300 may be assembled using other techniques according to various embodiments of the invention. The stack 307 may include more or fewer dies according to various embodiments of the invention.

In various embodiments, a single DLL or PLL in one of the dies 301-304 in the stack 300 is operated to generate a clock signal that is distributed to others of the dies 301-304 in the stack 300 through one or more of the channels 331, 332, 341, 342, and 343. The one of the dies 301-304 operated to generate the clock signal may be called a generator die or a source die, and the other ones of the dies 301-304 receiving the clock signal may be called receiver dies. Other DLLs or PLLs in the dies 301-304 can be shut off to reduce power consumption in the stack 300. In various embodiments, two or more DLLs or PLLs in the stack 300 are operated to generate clock signals that are distributed to the dies 301-304 through two or more of the channels 331, 332, 341, 342, and 343. A second one of the dies 301-304 operated to generate a clock signal may be called an auxiliary die operated to generate an auxiliary clock signal. Other DLLs or PLLs in the dies 301-304 are capable of being shut off to reduce power consumption in the stack 300. The dies 301-304 may include processors and/or memory devices such as Flash memory devices, DRAMs, or SDRAMs. The dies 301-304 may be of the same design or may be of different designs.

The stacks 100, 200, and 300 shown and described herein with reference to FIG. 1 through FIG. 3 are vertical stacks in which dies are arranged in a substantially linear orientation. The individual dies in a stack may be arranged on a planar surface such as a circuit board according to various embodiments of the invention. The individual dies in a stack may have any other order, arrangement, or orientation with respect to each other according to various embodiments.

FIG. 4 is a flow diagram of operations or methods 400 according to various embodiments of the invention. In block 410, the methods 400 start. In block 420, a clock signal is generated in a generator die in a stack of dies, the stack of dies including at least two dies including the generator die. In block 430, the clock signal is received in a receiver die in the stack coupled to the generator die. In block 440, the methods 400 end.

The individual activities of the operations or methods 400 do not have to be performed in the order shown or in any particular order. Some activities may be repeated, and others may occur only once. Various embodiments may have more or fewer activities than those shown in FIG. 4.

FIG. 5 is a block diagram of a system 500 according to various embodiments of the invention. The system 500 may include a processor 510, a first memory device 512, an image sensor device 520, a second memory device 525, a memory

controller **530**, a graphics controller **540**, an additional circuit **545**, an input and output (I/O) controller **550**, a display **552**, a keyboard **554**, a pointing device **556**, a peripheral device **558**, and a system transceiver **559**. The system **500** may also include a bus **560** to transfer information among the components of the system **500** and to provide power to at least some of these components, a circuit board **502** where some of the components of system may be attached, and an antenna **570** to wirelessly transmit and receive information to and from the system **500**. The transceiver **559** may operate to transfer information from one or more components of the system **500** such as the processor **510** or the memory device **525** to the antenna **570**. The transceiver **559** may also operate to transfer information received at the antenna **570** to at least one of the processor **510** and the memory devices **525** and **512**. Information received at the antenna **570** may be transmitted to the system **500** by a source external to the system **500**.

The system **500** may also include a switch **546** such as a push button switch coupled to the bus **560** and a power source **547**. The switch **546** may be engaged to couple power from the power source **547** to one or more of the components of system **500** such as the processor **510** or the memory device **512**.

The processor **510** may include a general-purpose processor or an application specific integrated circuit (ASIC). The processor **510** may include a single core processor or a multiple-core processor. The processor **510** may execute one or more programming commands to process information. The information may include digital output information provided by other components of system **500** such as the image sensor device **520** or the memory device **525**.

Each of the memory devices **525** and **512** may include a volatile memory device, a non-volatile memory device, or a combination of both. For example, the memory device **525** may comprise a dynamic random access memory (DRAM) device, a static random access memory (SRAM) device, a flash memory device, or a combination of these memory devices.

Each of the memory devices **525** and **512** and/or the processor **510** may be arranged in a stack of integrated circuit dies according to the various embodiments described herein, such as the stacks **100**, **200**, or **300** shown and described with reference to FIG. **1** through FIG. **3**. Each of the memory devices **525** and **512** and/or the processor **510** may be operated according to the operations or methods **400** shown and described with reference to FIG. **4**.

Some components of the system **500** may be arranged together such that the system **500** may include a system in package (SIP). For example, the memory device **512** and the processor **510** may be a part of a SIP **501** or the entire SIP **501** in which the memory device **512** may be used as a cache memory for the processor **510**. The memory device **512** may be a level L1 cache, a level L2 cache, a level L3 cache, or a combination thereof. The processor **510** and the memory device **512** may communicate with each other through one or more channels **521**.

The image sensor device **520** may include a complementary metal-oxide-semiconductor (CMOS) image sensor having a CMOS pixel array or charge-coupled device (CCD) image sensor having a CCD pixel array. The display **552** may include an analog display or a digital display. The display **552** may receive information from other components. For example, the display **552** may receive and display information such as text or images that is processed by one or more of the image sensor device **520**, the memory device **525**, the graphics controller **540**, and the processor **510**.

The additional circuit **545** may include circuit components used in a vehicle (not shown). The additional circuit **545** may receive information from other components to activate one or more subsystems of the vehicle. For example, the additional circuit **545** may receive information that is processed by one or more of the image sensor device **520**, the memory device **525**, and the processor **510** to activate one or more of an air bag system, a vehicle security alarm, and an obstacle alert system.

Clock signal distribution mechanisms presented herein may provide increased efficiency by reducing power consumption in a collection of dies. A clock signal from a DLL or a PLL or multiple clock signals from multiple DLLs or PLLs can be distributed through a collection of dies. One or more other DLLs or PLLs in the collection can be shut off to reduce power consumption. In addition, data may be clocked out of the dies according to the same clock signal. This can lead to a significant performance improvement.

Any of the circuits or systems described herein may be referred to as a module. A module may comprise a circuit and/or firmware according to various embodiments.

The Abstract of the Disclosure is provided to comply with 37 C.F.R. §1.72(b), requiring an abstract that will allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the claims. In addition, in the foregoing Detailed Description, it can be seen that various features are arranged together for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed embodiments require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of one or more of the disclosed embodiments. Thus, the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separate embodiment.

What is claimed is:

1. An apparatus comprising:

a plurality of dies coupled together through a plurality of channels wherein each of the plurality of dies comprises a respective clock generator circuit that is coupled to the plurality of channels for distributing a clock signal from a first clock generator circuit on a first die of the plurality of dies to the other dies of the plurality of dies, wherein the first clock generator circuit is enabled by a clock enable signal received from less than all of the other dies of the plurality of dies and each respective clock generator circuit of each of the other dies of the plurality of dies is shut off while the first clock generator circuit is enabled.

2. The apparatus of claim 1 wherein the first die is a generator die.

3. The apparatus of claim 1 wherein the clock generator circuits are one of a phase-locked loop or a delay-locked loop.

4. The apparatus of claim 1 wherein each die comprises a plurality of clock distribution terminals.

5. The apparatus of claim 1 wherein the clock enable signal is part of the plurality of channels.

6. The apparatus of claim 1 wherein clock generator circuits are phase-locked loops and delay-locked loops.

7. The apparatus of claim 1 further comprising each die of the plurality of dies is configured to generate the clock enable signal.

8. The apparatus of claim 7 wherein the first die is configured to generate the clock enable signal to enable the first die to use the clock signal.

9

9. A method for operating a plurality of dies, the method comprising:

enabling a plurality of clock generator circuits to generate a plurality of clock signals, each of the plurality of clock generator circuits located on a respective die of the plurality of dies;

distributing the plurality of clock signals to each die of the plurality of dies that has generated a clock enable signal; and

turning off clock generator circuits of each die of the plurality of dies that have not received the clock enable signal.

10. The method of claim 9 wherein enabling the plurality of clock generator circuits comprises each of the plurality of dies to receive the plurality of clock signals generating a respective clock enable signal.

11. The method of claim 10 further comprising generating the respective clock enable signals from the dies on which the plurality of clock generator circuits are located.

12. The method of claim 9 wherein distributing the plurality of clock signals comprises distributing the plurality of clock signals by straight line conductors or T-shaped clock distribution structures.

13. The method of claim 9 wherein enabling the plurality of clock generator circuits comprises enabling a plurality of delay-locked loops.

14. The method of claim 9 wherein enabling the plurality of clock generator circuits comprises enabling a plurality of phase-locked loops.

15. The method of claim 9 wherein turning off the clock generator circuits of each die of the plurality of dies that have

10

not received the clock enable signal comprises gating an external clock to those plurality of dies that have not received the clock enable signal.

16. A memory device comprising:

a plurality of memory dies coupled together through a plurality of channels; and

a plurality of clock generation circuits, each clock generation circuit coupled to a different die of the plurality of dies and each clock generation circuit to generate a clock signal that is coupled to the plurality of channels wherein a first clock generator circuit is enabled by a clock enable signal received from less than all of the other dies of the plurality of dies and each respective clock generator circuit of each of the other dies of the plurality of dies is shut off while the first clock generator circuit is enabled.

17. The memory device of claim 16 a plurality of gates coupled to the plurality of clock generation circuits and to an external clock signal, each of the plurality of gates to shut off its associated clock generation circuit by disabling the external clock signal to the associated clock generation circuit.

18. The memory device of claim 16 wherein the plurality of memory dies comprise a plurality of processors.

19. The memory device of claim 16 wherein the plurality of memory devices comprise Flash memory, dynamic random access memory, or synchronous dynamic random access memory.

20. The memory device of claim 16 wherein each clock generation circuit is a phase-locked loop and having an anti-fuse coupled to an enable/disable control line to enable/disable the respective phase-locked loop.

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